Designation: C 166 – 87 (Reapproved 1997)

Standard Test Method for Covering Capacity and Volume Change Upon Drying of Thermal Insulating Cement[1]

This standard is issued under the fixed designation C 166; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 Wet covering capacity and volume change upon drying are often of major importance in the application of thermal insulating cement. These properties can be easily determined at the same time that the determinations of dry covering capacity are made. Therefore, the procedures for determining these three properties are covered together in this test method.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 163 Practice for Mixing Thermal Insulating Cement Samples[2]

C 168 Terminology Relating to Thermal Insulating Materials[2]

3. Terminology

3.1 *dry covering capacity*—the area covered in "ft^2, 1 in. in thickness/100 lb of dry cement" (m^2, 1 cm in thickness/100 kg of dry cement) after the wet cement has been molded and dried to constant weight in accordance with Section 5.

3.2 *volume change upon drying*—the percentage change in volume of the wet molded cement that occurs when the dry cement is mixed with the recommended amount of water, molded, and dried to constant weight in accordance with Section 5.

3.3 *wet covering capacity*—the area covered in "ft^2, 1 in. in thickness/100 lb of dry cement'' (m^2, 1 cm in thickness/100 kg of dry cement) when the cement is mixed with the recommended amount of water and molded in accordance with Section 5.

3.4 Definitions in Terminology C 168 shall be considered as applying to the terms used in this test method.

4. Apparatus

4.1 *Mold*—A rigid mold having inside dimensions of 1 by 8 by 30 in. (25.4 by 203 by 726 mm) with one end and one face open, and a piece of wood or other suitable material 1 by 1½ by 7⅞ in. (25.4 by 38.1 by 200 mm) in dimensions for squaring up the end of the test specimen toward the open end of the mold.

4.2 *Wax Paper*—Sheets of wax paper 8 by 30 in. (200 by 762 mm) in dimensions.

4.3 *Engine Oil*.

4.4 *Trowel*—A 16-in. (about 400-mm) rectangular plasterer's trowel.

4.5 *Steel Rules*—Steel rules 18 and 36 in. (about ½ and 1 m) in length accurate to within 1⁄64 in. (0.5 mm).

4.6 *Depth Gage*—A depth gage consisting of a rigid, pointed rod approximately ⅛ in. (3 mm) in diameter, fitted with a flat disk about ½ in. (13 mm) in diameter which may be moved along the rod either by a sliding action or by means of threads.

5. Sampling and Mixing

5.1 The cement shall be sampled and mixed in accordance with Practice C 163.

6. Procedure

6.1 Oil the inside surfaces of the mold well, or line them with wax paper in order to prevent the cement from sticking to the sides and to permit convenient removal of the specimen. Then place the mixed cement in the mold.

6.2 Trowel the cement in one layer and in two directions lengthwise of the mold without unnecessary compacting, until the surface is smooth and flush with the top edges of the mold. Sufficient wet cement shall be used to fill the mold when the piece of wood or other suitable material is in place in the open end of the mold and in contact with the cement, in order to make a square end and to prevent movement of the cement after troweling is completed.

6.3 Measure the thickness at nine points on the top surface of the sample as indicated in Fig. 1.

6.4 Make the thickness measurements within an accuracy of ±2 % by means of a depth gage. Carefully push the point rod

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[1] This test method is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.31 on Chemical and Physical Properties.

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[2] *Annual Book of ASTM Standards*, Vol 04.06.

FIG. 1 Mold for Test Specimens and Locations of Points for Thickness Measurements

of the depth gage through the cement until it comes in contact with the bottom of the mold. Hold the rod constantly in a vertical position and adjust the disk until its flat surface just comes into contact with the top surface of the cement. Secure the disk to the pin before withdrawing the gage from the cement. Determine the thickness of the cement by measuring the distance from the flat surface of the disk to the pointed end of the rod with a steel rule or by some other suitable scale. Do not fill the indentations in the cement showing the points of measurement, but allow them to dry in place.

6.5 Make the width and length measurements with the steel rules within an accuracy of ±1⁄16 in. (about ±1.6 mm). Make the width measurements at locations approximately 6 in. (150 mm) from each end of the specimen. Make the length measurements at locations approximately 2 in. (50 mm) from each side of the specimen. While making these measurements, allow the edge of the steel rule to make an indentation in the wet cement in order to assure measurements at the same locations after the cement has been dried.

6.6 Immediately after the measurements have been made, or as soon thereafter as recommended by the manufacturer, place the cement specimen and mold in an oven at 215 to 250°F (102 to 121°C) until dried to constant weight. The oven chamber shall be adequately vented in such a manner as to ensure complete circulation of the atmosphere of the entire oven chamber, preferably by fan or other forced circulation method.

6.7 After the dried specimen has been weighed, measure it for thickness, width, and length at the same locations at which corresponding measurements were made before the specimen was dried. These locations are indicated by the indentation marks made in the wet cement. Measure the thickness as described in 6.4. In order to prevent false thickness measurements on the dry specimen, due to the bottom surface of the specimen having become warped in drying, remove the specimen from the mold and place a flexible steel rule so as to conform to the bottom surface of the specimen at points where the thickness is to be measured. Insert the point of the depth gage from the original top face until it touches the steel rule.

7. Calculations

7.1 *Values in U.S. Customary Units*—Calculate the wet and dry covering capacities and the volume change upon drying as follows:

$$C_w = dbl/1.44W \quad (1)$$

$$C_d = d_1 b_1 l_1/1.44W$$

$$V = [(dbl - d_1 b_1 l_1)/dbl] \times 100$$

where:

C_w = wet covering capacity, ft^2, 1 in. in thickness per 100 lb of dry cement,
C_d = dry covering capacity, ft^2, 1 in. in thickness per 100 lb of dry cement,
V = percentage volume change upon drying,
d = average thickness of wet specimen, in.,
b = average width of wet specimen, in.,
l = average length of wet specimen, in.,
W = weight of dry specimen, lb,
d_1 = average thickness of dry specimen, in.,
b_1 = average width of dry specimen, in., and,
l_1 = average length of dry specimen, in.

NOTE 1—Due to the wax paper or oil treatment preventing adhesion between cement and mold, the volume change (shrinkage) on drying will usually be greater in this test than that encountered in service, where adhesion is obtained between the cement and the surface on which it is applied.

7.2 *Values in SI Units*—Calculate the wet and dry covering capacities and the volume change upon drying as follows:

$$C_w = dbl/10^5 W \quad (2)$$

$$C_d = d_1 b_1 l_1/10^5 W$$

$$V = [(dbl - d_1 b_1 l_1)/dbl] \times 100$$

where:

C_w = wet covering capacity, m^2, 1 cm. in thickness per 100 kg of dry cement,
C_d = dry covering capacity, m^2, 1 cm. in thickness per 100 kg of dry cement,
V = percentage volume change upon drying, and other symbols,
d = average thickness of wet specimen, mm,
b = average width of wet specimen, mm,
l = average length of wet specimen, mm,
W = weight of dry specimen, kg,
d_1 = average thickness of dry specimen, mm,
b_1 = average width of dry specimen, mm, and,
l_1 = average length of dry specimen, mm.

8. Precision and Bias [3]

8.1 *Basis*—Three different laboratories tested the same product five times each for wet coverage, dry coverage, and percent volume change.

8.2 *Intralaboratory Precision*:

8.2.1 *Wet Coverage*—An average standard deviation, σ, of 1.7 % of the average mean, $\bar{x}$, for the three laboratories.

8.2.2 *Dry Coverage*—An average standard deviation, σ, of 1.7 % of the average mean, $\bar{x}$, for the three laboratories.

8.2.3 *Percent Volume Change*—An average standard deviation, σ, of 30 % of the average mean, $\bar{x}$, for the three laboratories.

8.3 *Interlaboratory Precision*:

8.3.1 *Wet Coverage*—The interlab standard deviation, σ,

[3] Supporting data are available from ASTM Headquarters. Request RR: C16–1011.

was 4.7 % of the mean, $\bar{x}$, of the lab means.

8.3.2 *Dry Coverage*—The interlab standard deviation, σ, was 4.3 % of the mean, $\bar{x}$, of the lab means.

8.3.3 *Percent Volume Change*—The interlab standard deviation, σ, was 41.1 % of the mean, $\bar{x}$, of the lab means.

8.4 *Bias*—No statement of bias is possible because absolute standards are not available.

9. Keywords

9.1 cement; thermal insulating; thermal insulating cements; thermal insulation materials; cement; volume change; wet covering capacity